

# The sampling apparatus of volatile organic compounds for wood composites

SHEN Jun, ZHAO Lin-bo, LIU Yu

Key Laboratory of Bio-based Material Science and technology, Northeast Forestry University, Ministry of Education, China, Harbin 150040, China

**Abstract:** Terpenes, aldehydes, ketones, benzene, and toluene are the important volatile organic compounds (VOCs) emitted from wood composites. A sampling apparatus of VOCs for wood composites was designed and manufactured by Northeast Forestry University in China. The concentration of VOCs derived from wood based materials, such as flooring, panel wall, finishing, and furniture can be sampled in a small stainless steel chambers. A protocol is also developed in this study to sample and measure the new and representative specimens. Preliminary research showed that the properties of the equipment have good stability. The sort and the amount of different components can be detected from it. The apparatus is practicable.

**Keywords:** Wood composites; Volatile organic compounds; Sampling apparatus; Design and manufacture

CLC number: X502

Document code: B

Article ID: 1007-662X(2005)02-0153-02

## Introduction

Since the concentrations of indoor volatile organic compounds (VOCs) increased (Baumann 1999a), indoor air quality has been taken care of. High levels of VOCs in indoor air will be harmful to human health. Many VOCs increase the risk of cancer or cause central nervous system depression, such as inability to concentrate, irritability, and sleepiness. Others may cause eye, respiratory irritation etc. For VOCs' emission will last a quite long time indoors, the potential risks of them cannot be ignored.

Indoor air emissions from wood products used interior and for the manufacturer of furniture and fixtures first centered on the release of a single VOC-formaldehyde, a suspected carcinogen. VOC emissions other than formaldehyde have been of increasing concern over the last two decades. People define them as a group of chemicals that contain carbon and readily evaporate. Up until now we still have known little about its emission from wood-composite products. They are found in a variety of wood products, such as flooring, panel wall, finishing, and furniture materials. The total kinds of VOCs are over 500 (Baumann, 2000). Terpenes, aldehydes, ketones, benzene, and toluene are examples of them.

The common adhesives used for wood composites are urea-formaldehyde resin (UF), phenolic-formaldehyde resin (PF), and polymeric methylene diisocyanate binder (pMDI) etc. Other additions are including wax, catalysts, preservative, fire-retardants and so on. The source of VOCs from wood composites can arise from any materials or products that compose a panel, e.g. wood species, wood components, adhesive content, adhesive cooking technology, type of board, wood carrying, end crosscutting, debarking, sanding and chip flaking, etc.. Hot pressing (Temp, time, pressure) also have great effects on them.

## VOCs sampling apparatus

American Society for Testing and Materials (ASTM) Standard

**Foundation Item:** This project is supported by the grand of the Oversea Back Scholar Research Startup of China Education Ministry, Heilongjiang Post-doctorial Research Startup and NEFU Creative Item.

**Biography:** SHEN Jun (1964), male, professor in the Material Science and Engineering College, Northeast Forestry University, Harbin 150040, P. R. China E-mail: Shenjunr@mail.hil.cn

**Received date:** 2004-4-1

**Responsible editor:** Chai Ruihai

D6330-98 provides a test method that is specific to the measurement of VOCs emission from newly manufactured individual wood-based panels, such as particleboard, plywood, and oriented strand board, for the purpose of comparing the emission characteristics of different product under the standard test condition. VOCs concentrations in the environment test chamber are determined by adsorption on an appropriate single adsorbent tube or multi-adsorbent tubes, followed by thermal desorption and combined gas chromatograph/mass spectrometry or gas chromatograph/flame ionization detection.

Since we even know little about VOCs in China before, VOCs sampling apparatus for wood composites and protocol have not been used. In this paper, equipment chamber system presented on Fig. 1 was designed and manufactured by Northeast Forestry University. The electro polished stainless steel test chambers had a nominal volume of 80 L and were located within a conditioned room maintained at 23 °C. Clean, humidified air was metered into each chamber at 1.0L/min, providing 1.13 air exchanges per hour to each chamber. The inlet and outlet ports consisted of tubes that extended to within 2 cm of the bottom of the chamber. Holes were distributed along the length of the tubes to assure adequate mixing of the inlet air with chamber air and to assure that air samples collected at the chamber outlet were an average of the chamber air.

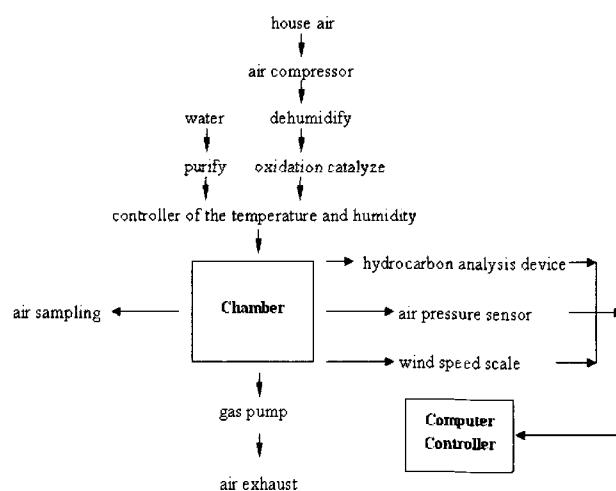


Fig. 1 Principle design of the experimental chamber system

A clean air supply to the chamber was generated by passing house-compressed air through sorbent towers and a catalytic oxidation unit. A portion of the dry, purified air was humidified using a temperature-controlled impinger containing hydrocarbon-free water and blended with dry air to produce 45% ( $\pm 5$ ) RH. The humidified air stream was then distributed to chamber.

Chamber outlet led to a rotary switching valve that allowed sequential sampling of air in the chamber without having to connect or disconnect tubing. All materials in contact with the sample air were constructed of stainless steel, glass, or Teflon. Chamber conditions during testing are shown in Table 1.

When VOCs sample collects from chamber, it will pass through a cryoconcentrator at  $-100^{\circ}\text{C}$ . Then the cryoconcentrator will be heated to  $150^{\circ}\text{C}$  for 5 min to transfer the VOCs to the gas chromatograph. The VOCs will cryofocussed at the head of the GC column at  $-100^{\circ}\text{C}$ , the column head then will be heated to  $150^{\circ}\text{C}$  within 15 s and hold for 3 min to inject VOCs into the GC column.

During separation of the VOCs, the GC column is held at  $-20^{\circ}\text{C}$  for 5 min, then heated to  $120^{\circ}\text{C}$  at a rate of  $10^{\circ}\text{C}/\text{min}$ , and held for another 5 min. This process gets adequate separation of the compound from wood composites. When the compound passes through the GC column, a mass selective detector at the GC column outlet is used to detect the various VOCs.

**Table 1. Parameters of chamber conditions**

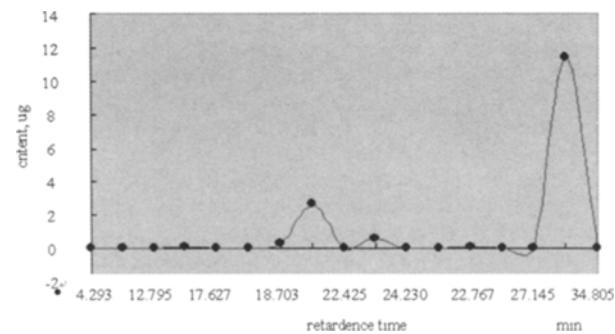
Parameter	value
Chamber volume	$0.080 \text{ m}^3$
Chamber air flow	$0.001 \text{ m}^3/\text{min}$
Temperature range	$10^{\circ}\text{C}$ – $40^{\circ}\text{C}$
Temperature precision	$\pm 0.3^{\circ}\text{C}$
Chamber humidity	$45 \pm 5\%$
Sample area	$0.021 \text{ m}^2$
Loading ratio	$0.40 \text{ m}^2/\text{m}^3$
GC sample volume	315 ml
Internal size	545 mm×410 mm×450mm

### VOCs elimination from wood composites

The concentration of VOCs from wood composites can be quite variable, and it is dependent on a number of factors, which involved in the production of the final product. These factors can be site location, wood source and type, wood-processing condition (drying and hot pressing temperature, pressure, time) and processing equipment, etc. VOCs standard sampling apparatus and analysis method can help people detect and quantity VOCs to meet the indoor air limit, e.g. for wood composites manufacturing, softwood and hardwood are mixed as raw materials. The emissions change in accordance with the extractives content of the species group (Baumann 1999b). The apparatus can be used to detect the VOCs type and concentration to help choose the right species group.

In our preliminary experiment, some recently produced particleboards were prepared from different plants. All ends and non testing surface of the samples were wiped by aluminum sheets in case of vapor emission. The exposure area of testing surface is  $0.02 \text{ m}^2$ . (200 mm×100 mm) The spectrum of VOCs emission from one of the particleboards produced in Northern China is shown on Fig. 2. According to the analysis by Heilongjiang Engineering Specialty Environment Testing Station, compared with the blank test, the components of the peaks include toluene, ace-

tic anhydride, xylene, cinnamene and Nov alkyl. This illustrates the chamber we designed can meet the basic sampling requirement. It is workable combining with GC/MS to detect, measure the kind and the concentration of the VOCs emitted from composites. Further research is still conducted in Northeast Forestry University, Harbin, China now. Results will be published later.



**Fig. 2 Spectrum of VOCs emission from one particleboard**

### Conclusion

The increased use of wood composites as substitute for lumber in application requires that we must know the VOCs emission during manufacture and use. This paper arose the question to spur the reconsideration. Research will be needed to evaluate the VOCs harmfulness. It is necessary to introduce and construct a standard apparatus and method to detect VOCs emission from wood composites. It will help us find an optimum technology to reduce or control the indoor pollution.

The equipment proposed in the paper demonstrated the determination and potential feasibility for us to control the harmful organic vapor of composites. The advantages of the sampling apparatus are reliable, easily operation, and with stable property. But it was still need us to further consummate after the set running past preliminary test.

### References

- American Society for Testing and Materials. 1998. Standard practice for determination of volatile organic compounds (excluding formaldehyde) emissions from wood-based panels using small environmental chambers under defined test conditions. ASTM D6330-98. ASTM, West Conshohocken, Pa.
- Barry, A.O. & Corneau, D. 1999. Volatile organic chemicals emissions from OSB as a function of processing parameters [J]. Holzforschung, **53**: 441–446.
- Baumann, M.G.D., Batterman, S.A., Zhang, G-Z. 1999a. Terpene emissions from particleboard and medium-density fiberboard products [J]. Forest Prod. J., **49**(1): 49–56.
- Baumann, M.G.D. 1999b. Air quality and composite wood products. Women in natural resources, [Http://IT.S.UIDAHO.EDU/WINR/](http://IT.S.UIDAHO.EDU/WINR/) **20**(4): 4–6.
- Baumann, M.G.D., Lorenz L.F., S. A. Batterman. 2000. Aldehyde emissions from particleboard and medium density fiberboard products [J]. Forest Prod. J., **50**(9): 75–82
- Brown, J.L., M.S. Black, and Sadie. S. 1989. Indoor air quality specification for Washington state natural resources building and labor and industries building. Washington State Dept. of General Administration
- Wighusz, R., Nikel, G., Igielska, B., and Sitko, E. 2002. Volatile organic compounds emissions from particleboard veneered with decorative paper foil [J]. Holzforschung, **56**(1): 108–110.